Space Weather Technical Forecast

Issued on Tuesday, 06 December 2022 at 13:40 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-Class flares throughout. Chance of G1/Minor Storm 7-8 Dec. Marginal Active electron fluence Likely Day 1 with Chance at end of period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24-hours, with occasional C-class flares observed by GOES16 and a peak of C2.0 at 05/1701UTC from AR3158 in the central northern hemisphere.

There were at most, seven sunspots on the visible disc. By far the largest group and most complex region on the disc was AR3153 (Fki/Beta) in the southeast, which showed proliferation and fading of intermediate spots. AR3158 (Dsi/Beta-Gamma) in the northwest has seen further spreading between its leading and trailing portions, with consolidation of existing spots and maturing penumbra. However, neither of these regions have seen notable flares. The remaining spots have shown little growth and remained relatively stable with one unnumbered region fading.

Around 05/1530UTC, a disturbance was noted across the southern end of a filament in the northeastern quadrant filament near 20E. This appears to have been a partial eruption as some of this feature was still apparent on subsequent H-alpha imagery. A second nearby event occurred at 05/2130UTC, with a smaller filament to the immediate northwest of the first also appearing to lift off. There was no evidence in available imagery of any Earth-bound Coronal Mass Ejections (CMEs) from these filament disturbances.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, were suggestive of a gradual exit from a recent fast wind from CH51/+ and the phi angle remained accordingly positive (away from the Sun) throughout.

Through the period, the solar wind speed showed a gradual decline from Slightly Elevated to Slow-Ambient levels, declining from 480km/s to around 390km/s. The solar wind density was initially Average, but fell to below average around 05/1800 UTC where it has largely remained. The IMF was relatively constant around 4nT, with a north-south range of +3 and -3nT.

Geomagnetic activity was Quiet throughout, with Kp levels of 0-2 throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels.

High energy electron flux (greater than 2MeV) at GOES16 ranged between Moderate and High in the period, peaking at 2610pfu at 05/1450UTC. The associated 24-hour Fluence was above the Active (1e8 integrated pfu) threshold for a time, but with the declining trend eventually seeing this fall narrowly below from 05/1800UTC. Observed fluence at 06/0001UTC was 9.63e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to remain at Low levels, with occasional C-class flares and a Chance of isolated M-class flares, most likely from AR3158 and AR3153. The complexity of the current sunspots is not reflective of their observed flare activity. No significant regions arrive or depart in the four days.

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Solar Wind / Geomagnetic Activity: No Earth-directed components of CMEs feature in the current forecast.
Solar wind speeds are in gradual decline as the residual influence of a fast wind stream from CH51/+ has faded. Enhancement of solar winds to Elevated levels expected by late Day 2 (7 Dec) due to the arrival of coronal hole fast winds. Winds expected to ease by the end of the period as HSS influence wanes.
Geomagnetic activity is expected to remain Quiet during the next 24-hours with a chance of Unsettled intervals. Active intervals likely with a Chance of G1/Minor Storms spanning late Day 2 and Day 3 (7-8 Dec), with activity then expected to return to Quiet as connection to the HSS weakens.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) at GEO is expected to remain at Background levels throughout. However, there is a very slight chance of Minor solar radiation storms as sunspot regions rotate westward.
High energy electron flux (greater than 2 MeV), as observed by GOES16, is expected to continue its current diurnal oscillation between Moderate and High levels. Flux levels are expected to fall later on Day 2 (7 Dec) or early Day 3 (8 Dec) in response to geomagnetic activity related to CH53/-. As influence from the HSS wanes, a recovery in electron flux levels is probable.
Fluence levels are currently at Background levels, but very close to the Active threshold (1e8 integrated pfu). Fluence is expected to cross the Active threshold on Day 1, followed by a probable declining trend due to HSS disruption. Recovery in levels likely on Day 4 (9 Dec), giving a chance of Active fluence.

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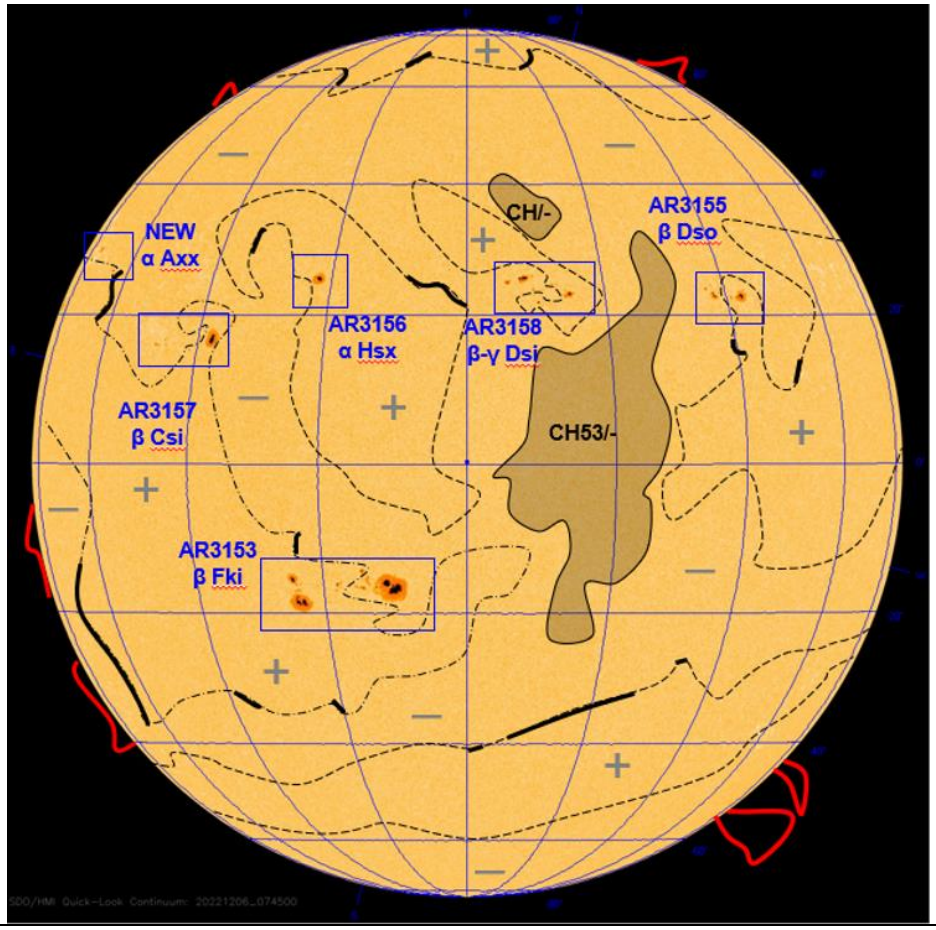
Figure 1. Solar Analysis Valid 06/0745 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Although minor filament eruptions have occurred on the visible disc in the past 24hours, there was no evidence of any Earth-directed CMEs on available imagery. No Earth-directed CMEs currently feature in the forecast period.

Solar wind speeds are currently at slow-ambient levels around 390 km/s and have been in gradual decline as the residual influence of a fast wind stream from CH51/+ fades. Enhancement of solar winds is expected by late Day 2 (7 Dec) due to the anticipated arrival of a high speed stream from the large CH53/- which dominates the western disc in SDO/AIA211 and 193 imagery. This recurrent feature is larger and much more pronounced relative to the last rotation. Uncertainty as to the effect of this feature lies with these changes as well as the temporal proximity to the solstice and semi-annual minima. Winds expected to gradually ease by the end of the period as HSS influence wanes.

The effects of CH53/- are yet to be observed at STEREO A. MOSWOC Enlil suggests a peak winds of 550km/s arriving on Day 3 (8 Dec), however onset late on Day 2 is still favoured and with strengths of 550-600km/s.

Geomagnetic activity is expected to be Quiet during the next 24-hours with a chance of isolated Unsettled intervals. The arrival of the HSS from late Day 2 sees Active intervals become likely, with a peak Chance of G1/Minor Storms spanning Days 2 and 3 (7-8 Dec). Geomagnetic activity

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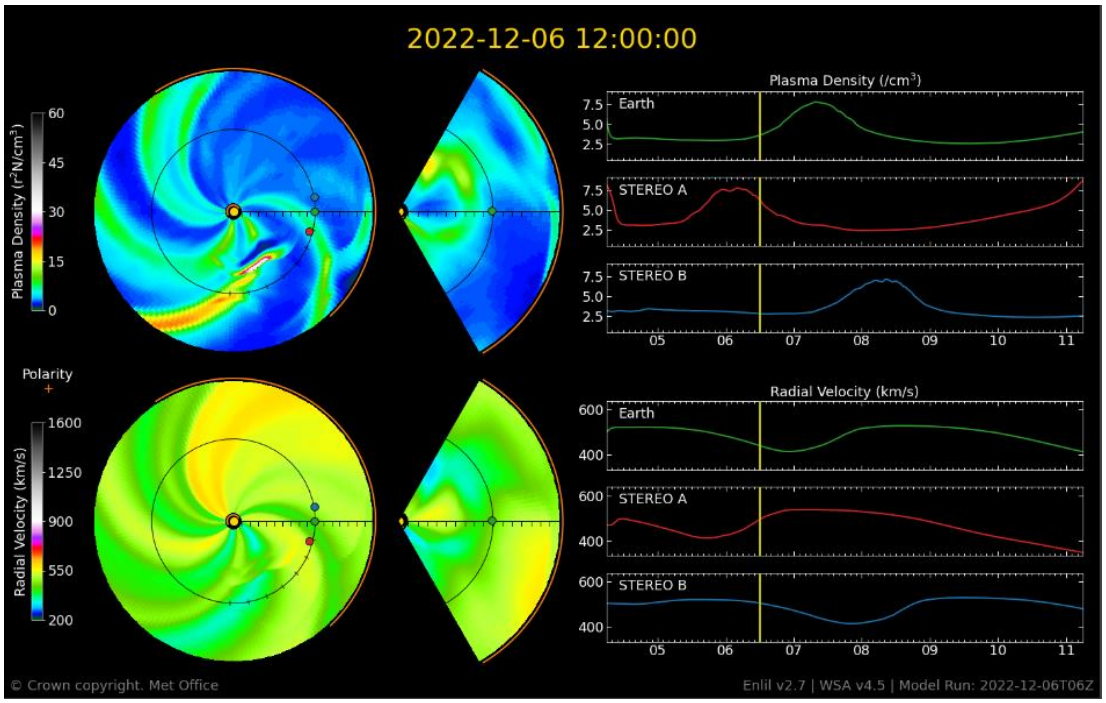
is expected to return to Quiet as connection to the HSS weakens.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	30	30	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil CMEs anticipated through the period.

Figure 2: MOSWOC Enlil showing arrival of HSS from CH53/- by 8 Dec.



Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the past 24-hours, with occasional C-class flares. Activity is likely to remain at Low levels, with a daily Chance of increasing to Moderate through the period. The largest group and most complex region on the disc remains AR3153 (Fki/Beta) in the southeast, which has continued to see proliferation and fading of intermediate spots. AR3158 (Dsi/Beta-Gamma) in the northwest has seen further spreading between its leading and trailing portions, with consolidation of existing spots and maturing penumbra. However, neither of these regions have seen notable flares. The remaining spots have shown little growth and remained relatively stable.

One further region may emerge over the eastern limb by Day 3 (8 Dec), otherwise all the sunspots likely to be present in the period are presently on the visible disc.

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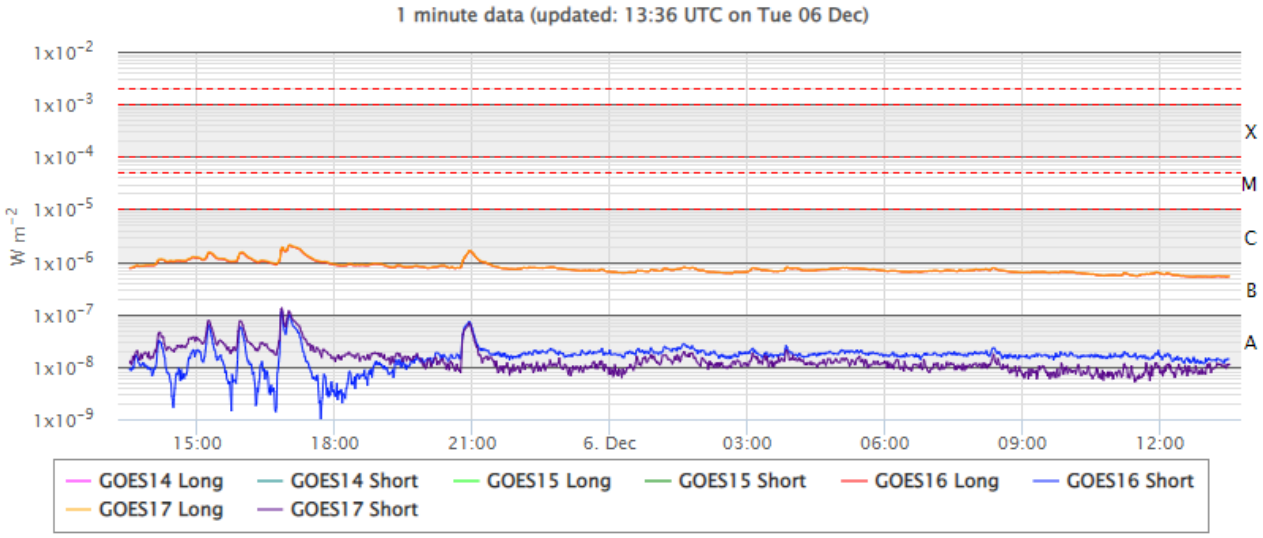
Despite the suggested complexity of the regions on the visible disc, this has so far failed to manifest in significant flare activity. As such, the daily probabilities of M-Class flare activity have been revised down from the suggested raw values.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16 X-Ray Trace showing Low levels of activity.



Solar Radiation Storms - (High Energy Protons):

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV), as observed by GOES16, is currently demonstrating a diurnal oscillation between Moderate and High flux levels. This pattern is

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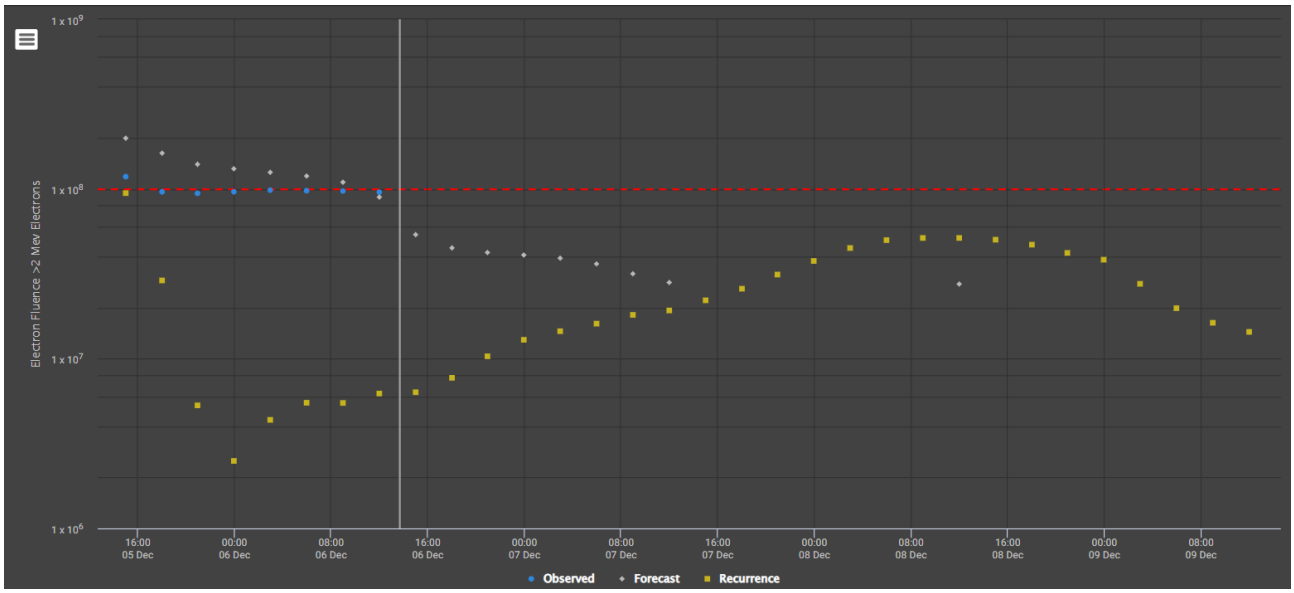
expected to continue until late Day 2 (7 Dec) or early Day 3 (8 Dec), at which point geomagnetic activity resulting from the arrival of CH53 may result in disruption and compression of the radiation belt. As influence from the HSS wanes, a recovery in electron flux levels is likely.

Levels of electron fluence are currently at Background levels, but very close to the Active threshold (1e8 integrated pfu). Fluence is expected to cross the Active threshold on Day 1, followed by a probable decline due to the arrival of the HSS and a recovery on Day 4 (9 Dec), once more giving a chance of Moderate fluence levels.
Confidence in the above forecast is relatively low, as flux and fluence levels are currently marginal and the driving coronal hole during the period is much-changed from the last rotation.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	80	60	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: REFM showing marginal Active fluence on Day 1 and a largely declining trend.



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